Maine Geologic Facts and Localities
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The Falmouth-Brunswick Sequence exposed at the Androscoggin Brunswick-Topsham Riverwalk

43° 55′ 02″ N, 69° 58′ 19″ W

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Introduction

The Androscoggin Brunswick-Topsham Riverwalk is an urban walking trail along the Androscoggin River in the towns of Brunswick and Topsham in midcoast Maine. This 1.25-mile trail has great views of the Androscoggin River above the hydro-electric dam, the Bowdoin Mill (now Sea Dog brewpub) in Topsham, the Cabot Mill at Fort Andross in Brunswick, and offers excellent opportunities to view aspects of the region’s natural geologic history. This publication aims to present aspects of the two units in the Falmouth-Brunswick bedrock sequence that are found along this path, and place the story of these exposures within the broader geologic history of southern Maine.

Figure 1. View of the Androscoggin River and Bowdoin Mill from the Riverwalk in Brunswick.
Figure 2. There are four public parking areas that provide easy access to the trail from Topsham and Brunswick.
Trail Details – Pedestrian Access

Access to the trail for pedestrians and cyclists is possible from a total of six points. They are as follows: in Topsham, at the end of Swinging Bridge (1), off Bridge St near Prospect St, at Summer St between Main St and Mill Rd (2), and at Main St between Summer St and the Frank J. Wood (“Green”) Bridge (3), and in Brunswick at Maine St between the Frank J. Wood (“Green”) Bridge and Fort Andross (4), at the Fort Andross Area (5), and at the end of the Swinging Bridge, off Mill St near Cushing St (6). Be sure to heed all cautionary signs.

Figure 3. Riverwalk trail map from [www.androscogginriverwalk.org](http://www.androscogginriverwalk.org).
Bedrock Geology

The most recent bedrock geologic map for this locality is Arthur Hussey and Henry Berry's map of the Bath 1:100,000 quadrangle. The Topsham side of the Androscoggin is primarily underlain by the Mount Ararat Formation (on the map as Oma). However Brunswick is largely underlain by the Nehumkeag Pond Formation (on the map as Onp). The region where the two units come into contact is not a straight line, and is rather defined by by a shape resembling a sin wave on the southwestern contact where the units interfinger. Because of this irregular pattern that stretches across the Androscoggin River, outcrops of both of the formations can be found along the riverwalk.

These two units are formations within the Falmouth-Brunswick sequence. The term “Falmouth-Brunswick” was introduced in 1985 by Bowdoin Professor Arthur Hussey to describe a belt of felsic (light-colored) and mafic (dark-colored) metamorphosed volcanic rocks, and metamorphosed volcanogenic sedimentary rocks. The units which make up the Falmouth-Brunswick sequence were initially included in the Casco Bay Group by Hussey (1988) but were separated by Hussey and Berry (2002).

Figure 4. Portion of the Bath 1:100,000 bedrock map (Hussey and Berry, 2002), annotated, showing the bedrock units in the area of the Androscoggin Riverwalk.
Androscoggin Swinging Bridge

This 520 foot suspension bridge was constructed in 1892 by John A. Roebling’s Sons Company, the engineering firm known for building the Brooklyn Bridge in New York City. It was originally intended to provide a path for mill workers residing in Topsham to reach Cabot Mill in Brunswick. A 1936 flood destroyed the superstructure of the bridge, and it was rebuilt in 1938 using the original cables.

Figure 5. Swinging Bridge over the Androscoggin River from the Brunswick shore.
Androscoggin Swinging Bridge

The 1909 Black Bridge lies upstream from the Swinging Bridge; once a double-deck railroad and suspended vehicular bridge, it is now closed to car traffic. Downriver, numerous rock exposures can be seen on the Topsham shore, on islands, and the Cabot Mill at Fort Andross can be seen prominently. The Cabot Mill is a reminder of Brunswick’s industrial past, where the power of falling water at Pejepscot Falls was harnessed to provide power for sawmills, cotton mills, and textiles. Today the old mill has been converted into office and business spaces, symbolic of the area’s revitalization and transition.

Figure 6. Looking downstream on the Androscoggin River from the Swinging Bridge.
Ledges at the water’s edge

On the Topsham side of the Androscoggin River near the base of the bridge, follow a short footpath on the downstream side to the ledges at the water’s edge.

The shore is lined with alternating light and dark gray rocks that have strongly developed layers of parallel, sheet-like layers dipping towards the river at an angle of approximately forty-five degrees. This distinctive rock unit is known as the Mount Ararat Formation or Mount Ararat Gneiss.

Figure 7. River ledges of Mount Ararat Gneiss.
Ledges at the water’s edge

Looking more closely at the rock, one can observe thin (1 to 5 cm) alternating bands of dark gray and light gray metamorphic rocks. The dark gray portions are known as amphibolite (rich in the dark mineral hornblende), and the light gray sections are granofels that contain quartz and feldspar. Using observations about the physical characteristics of these rocks leads geologists to conclude that they are igneous in origin, but they cannot completely answer questions about the relationship of this unit with the Nehumkeag Pond. Several hypotheses that could explain the original relationship of these igneous rocks to the Nehumkeag Pond; 1) the interlayered gneiss may represent volcanic flows erupted at different times during the deposition of the Nehumkeag Pond Formation; 2) the gneisses may represent deformed plutonic rocks that intruded the Nehumkeag Pond; 3) the contact between the Mount Ararat Formation and Nehumkeag Pond Formation may have been created by faulting prior to metamorphism (West and Cubley, 2010).

These are interpretations made by experienced geologists using inferences from facts and observations about the rock as well as information from similar units around the world. Several mountain building (tectonic) events have deformed and metamorphosed the original ash layers into a high-grade metamorphic rock known as gneiss. A felsic granofels sample from the Mount Ararat has been radiometrically dated to 471 ± 6 Ma by Hussey et al. (2010), which places it in the Ordovician Period.

Figure 8. Close up photo of Mount Ararat Gneiss.
Green Bridge Outcrops

Below the Frank J. Wood (“Green”) Bridge, examine the rocks near the red picnic table. The picnic table rests on a white coarse grained igneous rock called a pegmatite that is much younger than the Falmouth-Brunswick sequence. For more information on pegmatites, see the [Ichthyoglypts and other igneous animals, Topsham](#) field locality.

**Figure 9.** Photo of the Riverwalk area around the Green Bridge.
Green Bridge Outcrops

Near the water there are exposures of light to medium gray rocks containing the minerals quartz and feldspar. This unit, which resembles the light gray sections of the Mount Ararat Formation, is known as the Nehumkeag Pond Formation and consists of primarily felsic gneisses and granofels.

The Nehumkeag Pond was originally deposited as volcanic and sedimentary (of volcanic origin) rocks in an oceanic setting and were deformed and metamorphosed by later mountain building events. A sample of this unit has been dated to 472 ± 7 Ma by Hussey et al. (2010), placing it in the Ordovician Period.

Figure 10. Nehumkeag Pond formation outcrops near the Green Bridge.
The Frank J. Wood (“Green”) Bridge crosses the Androscoggin just downstream of the Pejepscot Dam. The dam is also the head of tide for this section of the Androscoggin River. From the bridge, ledges of gray Nehumkeag Pond Formation with some lighter pegmatites can be seen in the center of the dam and between the swirling rapids of the River. Historically, tens of thousands of Atlantic Salmon crossed Pejepscot Falls on their journey up the Androscoggin towards their spawning grounds. The installation of numerous dams along the Androscoggin has impeded the migration of the salmon; one attempt to assist the salmon was the installation of a fish ladder. This gray concrete structure on the Brunswick side of the dam was originally built in the 1980’s and is nearly 600 feet long and 40 feet high. While it is reported that “minimal” Atlantic salmon move through the ladder, river herring and other species pass through more often.

Figure 11. Photo of the river ledges below the dam and the fish ladder below the mill.
Falmouth-Brunswick Sequence Formation

The Falmouth-Brunswick sequence was deposited over 470 million years ago in an ancient ocean basin (Hussey et al., 2010). Volcanism, created by southeast subduction of an ancient ocean crust beneath part of the Gander microcontinent (Miramichi terrane), began in the middle Ordovician (Hussey et al., 2010). The forearc basin (the region between an oceanic trench and volcanic arc) accumulated the sediments that comprise the Falmouth-Brunswick sequence (Hussey et al., 2010).

Figure 12. Falmouth/Brunswick Casco Bay depositional setting in the Middle Ordovician. Figure from Hussey et al, 2010.
Falmouth-Brunswick Sequence Formation

At the time of the deposition of the Falmouth-Brunswick sequence, the microcontinent of Gander (GA) was separated from the ancestral North American continent (Laurentia) by the Iapetus ocean, and from Gondwana by the Rheic Ocean. Gander was moving away from Gondwana and approaching Laurentia (Domeier, 2016).

Figure 13. Continent configuration during the Middle Ordovician. Figure from Domeier, 2016.
How was the Falmouth-Brunswick Sequence deformed and metamorphosed?

Geologists follow the Principle of Horizontality, which states that sedimentary units were originally deposited as flat-lying layers. In the case of the Falmouth-Brunswick sequence, sediments that were volcanic in origin were deposited flat on the ocean floor. The Iapetus ocean, where the sediments were deposited, closed as the Gander microcontinent collided with Laurentia in a mountain building event called the Acadian orogeny. This occurred in the Devonian period approximately 400 million years ago and the sediments on the seafloor were pushed upward, folded, tilted, and subjected to high temperatures and intense pressure. The units have been tilted so they are now approximately 45 degrees from horizontal, a feature that is easily observed at the outcrop at the water’s edge.

Figure 14. Photo of tilted units in an outcrop along the river.


Internet Resources

Brunswick-Topsham Riverwalk Map: http://www.androscogginriverwalk.org/map--directions.html

Brunswick-Topsham Riverwalk Parking locations:
https://www.google.com/maps/d/viewer?mid=1x8yDvhOeivDPBu3miapvj8Js7YY&vps=2&hl=en&ie=UTF8&oe=UTF8&msa=0&ll=43.92023857830437%2C-69.96921499999996&z=16

Forecaster article about the fish ladder: http://www.theforecaster.net/dam-impact-brunswicks-once-great-salmon-run-down-to-a-trickle/

Forecaster article about the Brunswick-Topsham Riverwalk: http://www.theforecaster.net/fundraising-to-begin-for-brunswick-topsham-riverwalk/

Previous site of the month discussing pegmatite and graphic granite in Topsham:
http://digitalmaine.com/cgi/viewcontent.cgi?article=1428&context=mgs_publications

1957 MGS Publication on Maine Pegmatite Mines and Prospects:
http://digitalcommons.usm.maine.edu/cgi/viewcontent.cgi?article=1037&context=me_collection